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THE
INSTITUTES
OF
NATURAL SCIENCE,

EXHIBITING THE ARRANGEMENT FOLLOWED IN THE

LECTURES

DELIVERED

BY DR FLEMING,

IN THE

NEW COLLEGE, EDINBURGH.

"Non mihi res, sed me rebus subjungere coner."

-5 FEB 92

EDINBURGH:
PRINTED FOR THE AUTHOR, AND TO BE HAD AT THE
NEW COLLEGE, 80 GEORGE STREET.

Price 1/6.

PRINTED BY NEILL AND COMPANY, EDINBURGH.

TO

THOMAS CHALMERS, D.D.,
&c., &c., &c.,

PRINCIPAL AND PRIMARIUS PROFESSOR OF DIVINITY IN THE
NEW COLLEGE, EDINBURGH.

My Dear Sir,

Accept of this brief Exposition of the Subjects illustrated in the Class which has been entrusted to my care by the Free Church of Scotland, in the College over which you so honourably preside,—as a tribute of respect from your old and attached friend,

JOHN FLEMING.

New College, Edinburgh,
31*st October* 1846.

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INTRODUCTION.

1.

The *Stock of Knowledge* is the result of the accumulated discoveries of past ages. Its stability and progress secured by the art of Printing. Education renders this stock accessible. The duty of contributing to its increase. The question " *Cui bono*" considered, and the usual interval between the discovery of a truth and its useful application illustrated by examples.

2.

Nature.—The term used in various senses. The consequent ambiguity made use of by the infidel.

3.

Modes of Study.—The Analytical and Synthetical methods contrasted, with their peculiar advantages and defects. Theory and Hypothesis. The difficulty of establishing premises free from assumptions. The evils arising from the employment of mixed premises. The importance of distinct conceptions of the relations of Analogy, Affinity, and Identity; their transitions, and the errors generated by their substitution in processes of reasoning.

4.

CAUSATION.—*In reference to Power.* The word *Cause* used to express several different things. Antecedence, Invariable Antecedence, Necessary Antecedence, Efficient Antecedence. Man contemplated as an *Observer* and as an *Experimenter.* Mistakes of Hume and Brown on this subject.—*In reference to Purpose.* Proofs of Design in the agent. The peculiar fitness of the Natural and Physical Sciences for illustrating *Final Causes.* Error of Bacon. The abuse of Final Causes exemplified in Sir Isaac Newton's conjectures respecting Comets, and Paley's on the use of the Spleen.

5.

DEFINITION OF MATTER.—Its essential and secondary qualities. Extension and Divisibility. The infinite divisibility of matter, improbable, from observation and experiment. The *non-ultra* of magnitude and minuteness in organisms is probably dependent, in the former, on the strength of material, and in the latter, on the size of the ultimate simple or compound particles employed. The Attractions and Repulsions of the ultimate particles of matter, whether these be viewed as atoms or points, require careful study. The different *States* of matter, *Gaseous*, *Liquid*, and *Solid.*

6.

DIVISIONS OF THE SUBJECT.—The importance of an arrangement in which the subjects first illustrated, prepare for the examination of those which follow. The method here adopted is intended to secure this advantage, and is threefold.

SYNTHOLOGY.

The forces employed in the construction of inorganic *Masses.* The materials and mode of formation of Mineral Species.—MINERALOGY.

BIOLOGY.

The general characters of Living Beings, and the peculiar organisms of Plants and Animals.—PHYTOLOGY and ZOOLOGY.

GEOLOGY.

The present structure of the Earth, its revolutions and destinies.

These three departments of knowledge,—Synthology, Biology, and Geology,—when depending exclusively on *Observation*, constitute *Natural History.* When *Experiment* is conjoined with observation, and the *explanation* as well as the history of phenomena furnished, the term NATURAL SCIENCE, in contrast with Physical Science, has been adopted.

7.

The importance of Natural Science.—It trains the mind to habits of observation, and to detect resemblances and differences. It yields rational amusement along with the acquisition of important truths, and supplies materials for the guidance of the Agriculturist, the Miner, and the Fisher. It aids in comprehending Scripture imagery, furnishes the groundwork of Natural Theology, and constitutes a useful branch of Clerical Education, equally to the Home Minister and to the Foreign Missionary.

Throughout the course, the following method will be observed where practicable :—To ascertain the history of the phenomena or the *facts of the case*—To determine the plans, rules, or *laws of the case*,—and then consider the *adaptation* of these laws to the prevailing arrangements in the economy of Nature. —Keeping in view the advantages attending beginning with the *distinct* and proceeding to the *obscure*.

I. DIVISION.

SYNTHOLOGY.

Simple and compound masses. The test of a Simple or Elementary body. The Elements are few in number, and insufficient, without combination, for the construction of the required masses. By the composition of the Elements, a vast number of different kinds of masses, with peculiar properties, can be formed. In this process of composition, it is expedient, in the first instance, to attend to the *preparatory* operations executed by the "Attraction of Combination," and by which *materials* are formed for the *construction* of masses by the "Attraction of Cohesion."

I.

ATTRACTION OF COMBINATION.

Preliminary remarks on certain *Unions*, which, in their peculiar characters, serve to illustrate the Attraction of Combination.

1. Mixture.—This is an indefinate combination, unaccompanied by any obvious corpuscular action. It is best illus-

trated by attending to the ordinary means employed in the Arts, according to circumstances, to effect a separation—Rest, Agitation, Winnowing, Washing, Riddling, Filtering, Heating, &c.

2. DIFFUSION.—This is likewise an indefinite combination, but it is accompanied by corpuscular action. Thus, by the union of Alcohol and water, there is a change of density, and in the Alloys of the Metals, the hardness, elasticity, and tenacity, are changed. The *Diffusion of Gases*, and the peculiar construction of a mass of mixed gases.

3. SOLUTION.—This is, in some respects, a definite combination. *Solubility* and *Insolubility*. The amount of solid matter which a liquid can dissolve depends on specific affinities. *Saturation*. Proofs of corpuscular action. The same quantity of salt produces an equal increment of bulk, whether there be saturation or excess of liquid in the solution. The increase of heat exercises little influence in the case of water and common salt, while it augments the solvent power with Nitre, and diminishes it with Lime. The dependence of Solution on Diffusion.

Although these three processes of mixture, diffusion, and solution, are extensively employed in the destruction and formation of masses, it is the Attraction of Combination, usually termed *Chemical Attraction*, which here chiefly demands attention.

4. CHEMICAL ATTRACTION.—When two elementary bodies unite, under the influence of this attraction, each element loses its characteristic properties, and the compound, or *chemical particle*, exhibits specific qualities. Neutralization. In this kind of attraction, the combination takes place in reference to

Weight.

1. *In Definite Proportions.*—Thus, a given quantity of an element, as a base, is required to saturate a certain quantity

of acid, and as the elements differ in their saturating powers, tables of their relative proportions or *atomic weights* have been constructed. Example :—

Table of the Equivalents of the Elementary Bodies.

ELEMENTS.	Symbols.	Oxygen. = 1.	Hydrogen, = 1.	ELEMENTS.	Symbols.	Oxygen, = 1.	Hydrogen = 1.
1. Hydrogen	H.	0·125	1·0000	29. Selenium	Se.	4·945	39·63
2. Carbon	C.	0·754	6·04	30. Strontium	Sr.	5·473	43·85
3. Lithium	L.	0·803	6·44	31. Latanium	La.	5·549	44·39
4. Oxygen	O.	1·000	8·013	32. Cereum	Ce.	5·728	45·82
5. Boron	B.	1·362	10·91	33. Molybdendum	Mo.	5·985	47·96
6. Magnesium	Mg.	1·583	12·89	34. Rhodium	R.	6·514	52·20
7. Aluminum	Al.	1·712	13·72	35. Palladium	Pd.	6·659	53·36
8. Azote	Az.	1·770	14·19	36. Cadmium	Cd.	6·967	55·83
9. Phosphorus	P.	1·961	15·72	37. Tin	Sn.	7·353	58·92
10. Sulphur	S.	2·012	16·12	38. Thorinum	Th.	7·449	59·83
11. Fluorine	F.	2·338	18·74	39. Tellurium	Te.	8·017	64·25
12. Calcium	Ca.	2·560	20·52	40. Antimony	Sb.	8·064	64·62
13. Silicon	Si.	2·773	22·22	41. Barium	Ba.	8·569	68·66
14. Sodium	Na.	2·909	23·31	42. Vanadium	V.	8·569	68·66
15. Titanium	Ti.	3·036	24·33	43. Bismuth	Bi.	8·869	71·07
16. Glucinum	G.	3·312	26·54	44. Bromine	Br.	9·783	78·39
17. Iron	Fe.	3·392	27·18	45. Iridium	Ir.	12·335	98·84
18. Manganese	Mn.	3·459	27·72	46. Platinum	Pt.	12·335	98·84
19. Chromium	Cr.	3·518	28·19	47. Osmium	Os.	12·445	99·56
20. Cobalt	Co.	3·683	29·57	48. Tungsten	Tu.	12·462	99·69
21. Nickel	Ni.	3·697	29·62	49. Lead	Pb.	12·945	103·83
22. Copper	Cu.	3·957	31·71	50. Silver	Ag.	13·516	108·31
23. Yttrium	Y.	4·025	32·25	51. Iodine	I.	15·795	126·57
24. Zinc	Zn.	4·032	32·31	52. Columbium	Col.	23·074	184·90
25. Zirconium	Zr.	4·202	33·67	53. Gold	Au.	24·860	199·2
26. Chlorine	Cl.	4·426	35·47	54. Mercury	Hg.	25·316	202·87
27. Arsenic	As.	4·700	37·67	55. Uranium	U.	27·113	217·2
28. Potassium	K.	4·899	39·26				

2. *In Reciprocal Proportion.*—When two elementary bodies, such as Potash and Soda saturate, each in their definite proportion, any given acid, in the same *relative* proportion will they saturate any other acid with which they can combine.

3. *In Multiple Proportion.*—When two elements combine in different proportions to form definite compounds, the greatest combining quantities are multiples of the lowest.

4. *In Compound Proportion.*—When compound bodies unite, their saturating powers are equal to the sum of the powers of their components. Hence the atomic weight of a compound

is the sum of the atomic weight of its elements, the saturating power being inversely as the atomic weight.

Bulk.

Elementary bodies in a gaseous form unite in *Definite Volumes.* The volume of the compound, however, is not always equal to the sum of the bulks of the components, being sometimes less, but it always bears a very simple relation thereto. The remarkable simplicity of the relations of the volumes of the elements when compared with the atomic weights.

The circumstances favourable to Chemical Combination. Electrical state of the bodies uniting. Proofs of the action of Combination. Final results. Indestructible by mechanical means. Its importance in the economy of Nature.

II.

ATTRACTION OF COHESION.

The attraction of combination is necessarily heterogeneous. It multiplies the materials for the construction of masses, and may be considered as preliminary to the operations of cohesion. This Attraction is essentially homogeneous, building up masses of *one kind of particles*, whether these be elementary or chemical particles. Thus the diamond is built up, exclusively, with elementary particles of carbon, while calcareous spar consists of three elements, carbon, calcium, and oxygen, in the form of chemical particles of Carbonate of Lime. Proofs of polarity. Results destructible by mechanical means.

The characteristic features of this force, when acting unrestrainedly, are exhibited in masses being built up, according to the materials.—Definite,

1. *In Form.*—The mass, *externally*, is bounded by planes symmetrically arranged, the interfacial angles being constant for each species. The forms dependent on the materials which

have been employed. Crystals—their primary and secondary forms. *Internally*, the structure is indicated by *cleavage*, as distinguished from *fracture*. Isomorphism, Dimorphism, Crystallogeny.

2. *Density.*—Proofs that the particles of a cohesive mass are not in absolute contact. Suspended by a balancing of attractive and repulsive energies. Porosity usually the result of imperfect aggregation. Density, a valuable test of the purity of substances.

3. *Hardness.*—Precautions requisite in determining hardness. Degrees of hardness of certain bodies employed as standards, assigning to them numerical values for the sake of reference. Thus, Talc = 1°. Gypsum or Rock Salt = 2°. Foliated Mica = 2·5°. Calc-Spar = 3°. Fluor-Spar = 4°. Apatite = 5°. Scapolite = 5·5°. Felspar = 6°. Quartz = 7°. Topaz = 8°. Corundum = 9°. Diamond = 10°. Directions for using this table. Hardness influenced by mixture. Alloys.

4. *Elasticity.*—The peculiar position of the particles admitting of a certain displacement with restituency. Imperfection of springs. Elasticity of organisms.

5. *Ductility.*—Proofs of the particles shifting position yet preserving union. Viscidity.

6. *Brittleness.*—The limited range of restituency.

The force of cohesion attempted to be measured by the resistance of masses to disruption, by pulling, twisting, breaking, or crushing. The imperfection of experiments on this subject, arising from confounding cohesion with adhesion. The force of cohesion illustrated in the freezing of water.

Facility of motion among the particles in the act of arrangement favourable. Solution. Fusion. Sublimation.

The influence of small quantities of foreign matter on the results of cohesion, frequently of great amount.

III.

ATTRACTION OF ADHESION.

This is an action exerted between certain particles, simple or compound, and previous to, or after, the operations of cohesion. The particles or masses may be similar or dissimilar. Illustrated in the case of

1. *Solids to Solids.*—Stamping, Welding, Soldering, Cementing. In some cases, aided by one of the ingredients being in solution.

2. *Liquids to Liquids.*—Formation of drops. Viscidity of all liquids proved by resisting displacement. The force displayed.

3. *Airs to Airs.*—This attraction feeble in gaseous bodies. Opinions of Berthollet and Dalton.

4. *Solids to Liquids.*—Capillary attraction. Force exerted by moistened wood and ropes. Hygroscopes. Apparent repulsion. Prevalent errors.

5. *Solids to Airs. Catalysis.*—Influence of Charcoal, Platinum and Soils on Airs.

6. *Liquids to Airs.*—The diffusion of atmospheric air through water, necessary for the continuance of the life of many plants and animals.

Final Results.—The union of surfaces of similar or dissimilar particles or masses, by which aggregation, apart from form and structure, is effected. The importance of a knowledge of adhesion, as distinct from cohesion, in the study of inorganic and organised bodies.

IV.

ATTRACTION OF GRAVITATION.

The influence of the three preceding kinds of forces is exerted within a range so limited, that they are said to act at *insensible distances*. It is otherwise, with gravitation, the operations of which are influenced by *mass* and *distance*, and measured by *weight* and *motion*. It is the great aggregating power, influencing alike the products of combination, cohesion, and adhesion.

The general character of the action of gravitation on inorganic and organised beings, and the remarkable arrangements exhibited by the latter, in modifying or counteracting its effects.

V.

FRICTION.

This is the resistance offered by *rubbing* surfaces, and is the great antagonist to gravitation in preventing motion. The action of adhesion is at its maximum where friction does not take place. Dependent on the elasticity and structural character of the surfaces acting, and influenced by extent of surface, length of time in contact, the pressure and the velocity. Rendered intermittent by vibration. The *Angle of Repose* illustrated by sandhills and ditch-banks.

Friction necessary for the stability of many inorganic masses, and the requisite actions of living beings.

Review of Synthology, as giving obvious indications of Power and Design. Mistake of Paley in his "State of the Argument."

MINERALOGY.

Mineral Species.—The different states in which they occur. Often confounded with *Rocks*. *Individuals*, the product of cohesion. Aggregations of individuals formed by Adhesion. The objects of the science twofold. Prevailing errors.

Discriminative Mineralogy.—The relative importance of the physical and chemical characters employed. The value of the *Blowpipe* and *Tests*. Modes of procedure in determining a mineral. Specimens. Mineralogical Hammer.

Methodical Mineralogy.—The systems of Linnæus, Werner, Berzelius, Mohs, Philips, and Thomson, examined. Their advantages and defects.—A *Chemical System* recommended, depending on the Atomic Weights of the Elements, giving precedence according to the intensity of their combining or neutralising power. The advantages of this system, as keeping in view the operations of combination, cohesion, and adhesion, and as facilitating the study of Economical Mineralogy.

In the arrangement founded on the Atomic weights, the CLASSES must be as numerous as the elementary bodies, and the ORDERS as the number of combining elements *preceding* each class; while the SPECIES must depend in many orders on the different proportions in which similar elements unite.

Mineralogical Nomenclature.—Where practicable, the language of Chemistry should be employed, and the mode of constructing the terms, in certain cases, as used by Dr Thomson, be adopted. When the *Acid exceeds the base*, the Latin numerical adverbs serve as the indication. Thus, Sulphate, Bisulphate, Tersulphate, Quatersulphate. When there is only an atom and a half of acid present, it is sesquisulphate. When the *Base exceeds the acid*, the Greek numeral adverbs are employed, Sulphate, Disulphate, Trisulphate, Tetrasulphate.

The following examples may serve to illustrate the application of this Chemical system in classes occupying different positions in the regulating scale.

Class I.—HYDROGEN.

1. Order. Hydrogen in a free state can scarcely be said to occur in nature.

Class X.—SULPHUR.

1. Order. 1*st Species.* Native Sulphur.
2. Order. Sulphur and Hydrogen. 2*d Species.* Sulphuretted Hydrogen $=SH$. Diffused in rocks, and in solution in springs. Is it one of the forms of Malaria ?
3. Order. Sulphur, Hydrogen, and Oxygen. 3*d Species.* Sulphuric Acid, SO_3+HO.
4. Order. Sulphur, Magnesium, Hydrogen, and Oxygen. 4*th Species.* Epsom Salts, or Sulphate of Magnesia $=$ $Mg\,O+SO_3+7\,HO$.
5. Order. Sulphur, Aluminum, Hydrogen, and Oxygen. 5*th Species.* Sulphate of Alumina $=Al\,O+SO_3+6\,HO$. 6*th Species.* Trisulphate of Alumina $=3\,Al\,O+SO_3+9\,H\,O$.

Class XX.—COBALT.

1. Order. The element not found free, but as an alloy, or base.

2. Order. Cobalt and Oxygen. 1*st Species.* Oxide of Cobalt $= Co\ O$.
3. Order. Cobalt and Sulphur. 2*d Species.* Sulphuret of Cobalt $= Co\ S$.
4. Order. Cobalt, Sulphur, Oxygen, and Hydrogen. 3*d Species.* Disulphate of Cobalt $= 2\ Co + SO_3 + 9\ HO$.

Class XXX.—Strontium.

1. Order. The element not found free.
2. Order. Strontium, Carbon, and Oxygen. 1*st Species.* Strontianite or Carbonate of Strontia $= Sr\ O + CO_2$
3. Order. Strontium, Sulphur, and Oxygen. 2*d Species.* Celestine, or Sulphate of Strontia. $= Sr\ O + SO_3$

Class XL.—Antimony.

1. Order. 1*st Species.* Native Antimony $= Sb$.
2. Order. Antimony and Oxygen. 2*d Species.* Sesquioxide of Antimony $= Sb\ O_{1\frac{1}{2}}$. 3*d Species.* Antimonous Acid $= Sb\ O_2$. 4*th Species.* Antimonic Acid $= Sb\ O_{2\frac{1}{2}}$. 5*th Species.* Antimonophyllite of Breithaupt.
3. Order. Antimony and Sulphur. 6*th Species.* Grey Antimony, or Sesquisulphuret of Antimony $= Sb\ S_{1\frac{1}{2}}$. 7*th Species.* Red Antimony $= Sb\ O + Sb\ S_{1\frac{1}{2}}$.
4. Order. Antimony, Calcium, and Oxygen. 8*th Species*, Romeine, or Biantimonite of Lime $= 2\ Sb\ O_2 + CO$.
5. Order. Antimony, Sulphur, and Iron. 9*th Species.* Berthierite, or Sesquisulphuret of Antimony, and Sulphuret of Iron $= Sb\ S_{1\frac{1}{2}} + Fe\ S$. 10*th Species.* Bisesquisulphuret of Antimony and Sulphuret of Iron $= 2\ Sb\ S_{1\frac{1}{2}} + Fe\ S$.
6. Order. Antimony and Arsenic. 11*th Species.* Arsenical Antimony $= Sb\ As_2$
7. Order. Antimony and Nickel. 12*th Species.* Antimoniuret of Nickel $= Sb\ Ni$.
8. Order. Antimony, Nickel, and Sulphur. 13*th Species.*

Antimoniuret of Nickel and Sulphuret of Nickel $= Sb\ Ni + Ni\ S$.

Class L.—Silver.

1. Order. 1*st Species.* Native silver, more or less alloyed with other metals.
2. Order. Silver, Carbon, and Oxygen. 2*d Species.* Carbonate of Silver $= Ag\ C_2$.
3. Order. Silver and Sulphur. 3*d Species.* Vitreous Silver Ore, or Sulphuret of Silver $= Ag\ S$. 4*th Species.* Flexible Sulphuret of Silver.
4. Order. Silver, Sulphur, and Iron. 5*th Species.* Sternbergite, or Sulphurets of Iron and Silver.
5. Order. Silver, Sulphur, and Copper. 6*th Species.* Sulphurets of Copper and Silver.
6. Order. Silver and Chlorine. 7*th Species.* Corneous Silver Ore, or Chloride of Silver $= Ag\ Cl$.
7. Order. Silver, Arsenic, and Sulphur. 8*th Species.* Light red Silver Ore, Surphurets of Silver and Arsenic.
8. Order. Silver, Arsenic, and Iron. 9*th Species.* Arsenical Silver Ore.
9. Order. Silver, Selenium, and Copper. 10*th Species.* Eukairite, or Seleniurets of Copper and Silver.
10. Order. Silver and Tellurium. 11*th Species.* Bitelluret of Silver $= Ag\ Te_2$.
11. Order. Silver and Antimony. 12*th Species.* Disantimoniuret of Silver $= Sb\ Ag_2$? 13*th Species.* Trisantimoniuret of Silver $= Sb\ Ag_3$?
12. Order. Silver, Antimony, and Sulphur. 14*th Species.* Brittle Silver Glance $= 3\ Ag\ S + Sb\ S_2$? 15*th Species.* Ruby Silver $= 1\frac{1}{2}\ Ag\ S + Sb\ S_{1\frac{1}{2}}$? 16*th Species.* Hemiprismatic Ruby Blende, or Margarite $= 11\ Sb\ S_{1\frac{1}{2}} + 6\ Ag\ S_{1\frac{1}{2}}$?
13. Order. Silver, Antimony, Copper, and Arsenic. 17*th Species.* Polybasite.
14. Order. Silver and Bromine. 18*th Species.* Bromide of Silver $= Ag\ B$.

15. Order. Silver, Lead, and Selenium. 19*th Species.* Seleniurets of Silver and Lead.
16. Order. Silver, Lead, Sulphur, and Antimony. 20*th Species.* Peritomous Antimony Glance ?

CLASS LV.—URANIUM.

1. Order. O.
2. Order. Uranium and Oxygen. 1*st Species.* Pitch Blende, or Protoxide of Uranium $=UO$.
3. Order. Uranium, Sulphur, and Oxygen. 2*d Species.* Sulphate of Protoxide of Uranium $=UO+SO_3$. 3*d Species.* Sulphate of Peroxide of Uranium $=UO_2+SO_3$.
4. Order. Uranium, Hydrogen, Oxygen, Phosphorus, and Calcium. 4*th Species.* Uranite, or Hydrated Phosphate of Peroxide of Uranium and Lime $=2\,UO_2\,PO_{2\frac{1}{2}}+Ca\,PO_{2\frac{1}{2}}+12\,HO$.
5. Order. Uranium, Hydrogen, Oxygen, Phosphorus, and Copper. 5*th Species.* Chalcolite, or Hydrated Phosphate of Peroxide of Uranium and Copper $=2\,UO_2+Cu\,OPO_{2\frac{1}{2}}+12\,HO$.
6. Order. Uranium, Columbium, and Oxygen. 6*th Species.* Columbate of Protoxide of Uranium $=UO+Col\,O_3$.

II. DIVISION.

BIOLOGY.

The characteristic differences of Inorganic and Organised beings.

The peculiar structure of Organisms. Cellular, membranous, and vascular tissues. Cytoblasts. The subordinate and symmetrical development of parts. The harmony of structures.

VITALITY.

Is LIFE the cause or the effect of organization? A crystal and an organism contrasted.

1. *Characters of Vitality.*

a. It is limited and specific in its operations, according to the species, in reference to Magnitude, Form, Structure, Composition, and Duration.

b. It exhibits Irritability. This character intimately connected with the fibrous structure.

c. Its Instinctive operations regulate the supply of food, obviate difficulties, and repair injuries.

d. Is Procreative. The transmission of specific character.

2. *Conditions requisite for Vital Development.*

a. Parentage. Equivocal Generation considered.

b. Moisture. Liquid and solid matter in very different proportions, according to the Organism.

c. Temperature. The connection of development with the seasons, an obvious proof of presiding Wisdom.

d. Atmospheric air. The use of oxygen in the support of life.

e. Food. Constant waste and supply of materials.

3. *Modifications of Vitality.*

The healthy and diseased states. Murrains.

Monstrosities—through defect, excess, or substitution.

POLITY OF NATURE.

The *Dependence* of the organised on the inorganic kingdom. The mutual dependence of plants and animals.

Means of *Preservation* of organised beings. The limited surface and limited fertility of the earth regulate the numbers of plants and animals. Origin of the opinion that no species have been *lost.* The numerous facts which lead to an opposite conclusion.

Review of opinions respecting Progressive Development, and the transmutation of species.

An examination of the statements on which the notion of a *Chain of Being* has been founded. Important mistakes here committed.

The *Distribution* of living beings, geographical and physical. Influencing circumstances. Illustration of *Specific Centres of Distribution. Generic Centres of Distribution.* Each species governed by its own laws—a truth greatly overlooked by speculating Geologists.

PRINCIPLES OF CLASSIFICATION.

The importance of distinct conceptions of the meaning of the terms *Species* and *Variety.* Modes of grouping Species, Genera, Families, and Classes. The essential difference between Discriminative and Systematical Arrangements.

The Discriminative method essentially *artificial.* The use of positive and negative characters recommended.

The *Natural Method* professes to arrange organisms according to their affinities. The mistakes of Jussieu, Cuvier, and others, on this subject. The Natural Methods, intended as *Systems,* may be as numerous as the organs and functions of living beings.

FIRST SUBDIVISION.

PHYTOLOGY.

The characteristic differences of Plants and Animals.

I. Vegetable Tissues.—The *Composition* of Tissues,—the carbonaceous, earthy, and saline ingredients. The *Structure* of Tissues, as cellular, ligneous, or vascular. The *Contents* of Tissues,—Chlorophylle, Starch or Raphides. The *Epidermis*, its appendages and Stomates. Plants, divided into Cellular and Vascular.

II. The Seed.—The *Integuments* and *Scar.—Naked Seeds.* The *Germ* and its store of nourishment. Acotyledonous, Monocotyledonous, and Dicotyledonous plants. The circumstances favouring *Germination.* The evolution of the Radicle and Plumule. Malting. The qualities of good seed.

III. The Root.—Usually an organ of nourishment, sometimes only of support. The *Rootlets* are readily reproduced. Are selective *absorbants.* Is there evidence of *excretion* as influencing the *rotation of crops*? Roots as stores of *nourishment.* Remarks illustrating the *food of plants*, and the action of *manures.*

IV. The Stem.—The *collar* as the dividing plane between root and stem. In some plants the stem consists of *Bark, Wood*, and *Pith.* The characteristics of *Acrogens*, *Thallogens*, *Rhizogens*, *Endogens*, and *Exogens.*

V. Buds.—The *Leaf-buds*, mode of formation, nourishment and evolution. *Flower-buds,* and circumstances favourable to their production. Singular law of vegetable life in reference to those two kinds of buds. Influence of *climate. Dormant Buds.*

VI. LEAVES.—Important organs, and in many useful plants readily reproduced. The *structure* of the leaf, as cellular or vascular, with the fibres diverging parallel or reticular. Leaves, as absorbants and exhalents, elaborating food. The circulation of the *Sap. Perdifoils* and *Evergreens.* Misconceptions respecting the latter. The proper season for *Felling* timber for particular purposes.

VII. THE FRUIT.—The *Stamen* and *Stigma* and the accessary organs of *Calyx* and *Corolla.* The *Seed-vessel. Agamous* and *Phœnogamous* Plants. *Dispersion* of the seed. *Viviparous* plants, Bulbs, Tubers, Runners. By means of *seed* individuals are propagated; by *cuttings,* individuals are extended. Difference in the vitality of the plants derived from these two sources. Conditions requisite for grafting and budding.

VIII. DURATION OF PLANTS.—Annuals, Biennials, and Perennials. The number of times in which an individual can produce flowers and fruit. Modes of determining the *age* of plants.

IX. CALENDAR OF FLORA.—The *hybernation* of plants. The plants most suitable for insertion in a register. The indications of the progress of temperature with the season.

X. CLASSIFICATION OF PLANTS.—*Discriminative Methods.* The *Sexual* System of Linnæus. The *Dichotomous* Method.

Natural Methods.—The systems of Ray, Jussieu, and Lindley briefly considered. The latter author gives the following tabular view of the vegetable kingdom.

Asexual, or Flowerless Plants.

Stems and leaves undistinguishable,	I. THALLOGENS.
Stems and leaves distinguishable,	II. ACROGENS.

Sexual, or Flowering Plants.

Fructification springing from a thallus,	III. RHIZOGENS.
Fructification springing from a stem.	
Wood of stem arranged in a confused manner, youngest in the centre; cotyledon single.	
Leaves parallel-veined, permanent; Root much like the stem internally,	IV. ENDOGENS.
Leaves net-veined, deciduous; Root with the wood in a concentric circle,	V. DICTYOGENS.
Wood of stem arranged in a concentric or uniform manner, youngest at the circumference; cotyledons 2 or more.	
Seeds quite naked,	VI. GYMNOGENS.
Seeds enclosed in seed-vessels,	VII. EXOGENS.

XI. HERBARIUM.—The selection, drying, arranging, and preserving *Specimens.* Modes of Investigation.

SECOND SUBDIVISION.

ZOOLOGY.

1.

ANIMAL TISSUES.

The substances employed in the *composition* of Tissues. Gelatine, Albumen, Fibrin, Earthy matter, and Fat. The cellular, fibrous, vascular, and pulpy *structures* of tissues. Vascular and extravascular parts. The important difference between organic and animal life.

2.

SYSTEMS OF ORGANS.

1. Cutaneous System.—Its structure, appendages, and secretions. Its important discriminative characters in classification.

2. Supporting System.—Bone, Cartilage, Shell, Crust, and Spicula. Variety of articulations.

3. Muscular System.—The *structure* and mode of action of muscles. *Voluntary* and *Involuntary* muscles. Alternate periods of action and repose.

4. NERVOUS SYSTEM.—The grey and white matter. Brain, Nerves, and Ganglia. Functions of the nervous system as subservient to *Sensation*, *Volition*, *Reflection*, and *Organic Life*.

5. NUTRITIVE SYSTEM.—The Kinds of *Food*. Modes of *securing* it. *Preparation* of the food; mastication, saliva, deglutition. *Digestion* and its results. The *Lacteals*. *Blood*. Respiration. The Pulmonic and Systemic vessels. *Lymphatics*. Secreting and excreting organs. *Peculiar Secretions*. Light, Heat, and Electricity.

6. REPRODUCTIVE SYSTEM.—Viviparous, Oviparous, Ovoviviparous, Androgenous, Gemmiparous, and Fissiparous animals. Peculiar arrangements for the wellbeing of the young. *Hybrids*. The circumstances under which they are produced, and their limitations.

3.

GENERAL PSYCHOLOGY.

The importance of attending to the different degrees of mental development in the lower animals, as illustrative of the intellectual philosophy of man.

1. THE INSTRUMENTS OF OBSERVATION.—The *Senses* of Touch, Heat, Sight, Hearing, Smell, and Taste. The peculiar kinds of information furnished by the six senses depend on the states of the organs, and their relations to objects. The co-operation of the senses.

2. MENTAL OPERATIONS.—Attention, Memory, Imagination, Reasoning, Resolving. The intellectual operations of the lower animals.

3. INSTINCTIVE OPERATIONS.—The Active and Instinctive Powers identical. The difference between *Reason* and *Instinct*. The division of the instinctive powers into Appetites,

Desires, and Affections, founded on limited views of nature. The following new division is proposed.

A.

Conservative Instincts.

Temperature. Shelter, Torpidity, and Migration.—*Sleep.* The times, places, and positions. The characteristics of normal sleep. Dreaming. Somnambulism. Mesmeric sleep?—*Society.* The social instincts involve co-operation, and the means of communicating changes. Signs. Sounds. Language. The peculiar character of the Language of Man.—*Restraint,* largely modified by experience.—*Love of Life.* Modes of avoiding pain and death, as force, flight, and stratagem.

B.

Nutritive Instincts.

The *season* of activity. Diurnal, Crepuscular and Nocturnal Animals. The *discrimination* exercised. The modes of *capturing* and killing prey. The *storing* propensities of some animals.

C.

Procreative Instincts.

Parental preparations and subsequent duties. The *filial* instincts yield the requisite reciprocity. Education.

All these three classes of Instincts require to be studied in connection with the subservient organs.

The Distinguishing Characters of Man and the Lower Animals.

The superiority of Man dependent on a number of co-operating arrangements. Is the Soul immortal because of its *immateriality*, or because it is *one* and indivisible ? Erroneous views on this subject.

4.

LOCAL DISTRIBUTION OF ANIMALS.

Resident Animals. Regular *Visitants* in summer or winter. *Stragglers.* Domestication, and its influence on the size, form, and colour. *Extirpated* Animals. *Extinct* Animals.

5.

CLASSIFICATION OF ANIMALS.

The different principles of classification which have been adopted. The importance of structural and functional characters. The different Classes of Zoologists.

I.

VERTEBRATA.

This group of the twofold division of the animal kingdom includes beings having many common properties. Is capable of an equally important subdivision into warm-blooded and cold-blooded Vertebrata.

1. *Warm-blooded Vertebrata.*

1. QUADRUPEDS.—Man. Quadrumana. Cheiroptera.

Feræ. Plantigrada. Digitigrada. Glires. Pecora. Belluæ. Palmata. Cetacea. Marsupialia. Monotremata.

2. Birds.—Gallinacea. Accipitres. Passeres. Grallæ. Palmipedes.

2. *Cold-blooded Vertebrata.*

1. Reptiles.—Chelonia. Sauria. Ophidia. Batrachia.

2. Fishes.—Chondropterygia. Malacopterygia. Acanthopterygia. Ganoid, Placoid, Ctenoid, and Cycloid, scales. Heterocercal and Homocercal, tails.

II.

INVERTEBRATA.

1. Mollusca.—Cephalopoda. Pteropoda. Pulmonifera. Branchifera. Brachiopoda. Bivalvia. Tunicata.

2. Annulosa.—Crustacea. Cirripeda. Arachnida. Insecta. Myriapoda. Annelida. Entozoa.

3. Radiata.—Echinodermata. Acalepha. Zoophyta. Infusoria.

Modes of examining and preserving animals. Wet and dry preparations. Powders and liquids employed.

III. DIVISION.

GEOLOGY.

The study of the science of Geology is attended with peculiar difficulties. It is dependent on Mineralogy, Phytology, and Zoology. Prevailing inadequate conceptions on this subject. The harmony between the Works and the Word of God, when rightly interpreted.

The general character of the Earth as a Planet. Its form and density. The views of Cosmogonists illustrated by the opinions of Buffon, Herschell, and La Place.

I.

THE ATMOSPHERE.

1. LIMITS AND PRESSURE.

Consideration of the proofs usually adduced for the limited extent of the atmosphere, and their coincidence.

The *weight* of the air as measured by the Barometer. The variations of pressure as connected with the weather. The daily variation. The influence of latitude. The structure of organisms in connection with pressure. The effects of change of pressure on man in ascending mountains and in using the diving-bell. The air apparatus of Birds and Fishes. Suckers.

2. CONTENTS.

The probable origin of the Oxygen, Azote, and Carbonic Acid, and the displays of compensation which they furnish. Their *mixed* state.

The *vapour*, its origin and the mode of estimating its quantity. *Clouds*, their origin and nomenclature. The *spray* of the sea widely diffused, and the probable cause of blights.—Its influence on littoral vegetation, and on rain water for domestic purposes.

The extraneous gases and salts occasionally present in the atmosphere, and their probable origin. *Miasms*. *Meteorites*. Their different kinds. Meteoric Iron, Stones, Dust. Review of opinions respecting their origin.

3. TEMPERATURE.

The heat of the atmosphere chiefly derived from the action of the Sun on the surface of the Earth. The difficulty of making accurate thermometrical observations.

The influence of *Latitude* on the Temperature, modified by local circumstances.

The influence of *Altitude*. The height of perpetual congelation. Anomalous facts.

The *Isothermal*, Isocheimal, and Isothereal Lines of Humboldt.

The *daily variation*. The curve of daily temperature, as determined by observations at Leith Fort and elsewhere.

The *annual variation*. The curve of annual temperature, and its influence on living beings.

An examination of the popular opinion that the climate of this country has deteriorated.

4. CURRENTS.

The cause of currents, not confined to solar influence. Other causes in operation.

The *Land and Sea Breeze.* Its limited character.

The *Trade Winds.* Equatorial and Polar currents. The influence of the rotation of the Earth.

Monsoons. Their duration and direction.

Hurricanes. The cause not directly connected with temperature. Their rotatory and intermittent character.

Modes of judging of the *weather.* *Critical* days.

II.

THE WATERS.

1. THE SUPPLY OF WATER FROM THE ATMOSPHERE.

The formation of *Dew.* State of the air when deposited. *Hoar-Frost,* and the character of those places most frequently subjected to its influence.

Mist; its origin in summer and in winter.

Rain; its mode of production imperfectly understood. Its local distribution. The influence of latitude and altitude. Good observations wanting.

Rain-Gauges. The effects of size and elevation above the ground on the quantity of water collected.

The *Economical uses* of Rain-water. How collected, filtered, and preserved. A neglected subject at home and in the colonies. The quantity of daily supply to each individual in the large towns.

2. THE ORIGIN AND CHARACTER OF SPRINGS.

Portions of the rain-water escape by the surface and by evaporation, while another portion sinks into the ground, and is variously modified in its direction, temperature, and contents.

1. *Direction.*—Pervious and impervious strata. Fissures. Modes of *Draining.* Artesian Wells, and conditions under which they may be successfully sought after. The quantity of water delivered is dependent on various circumstances.

2. *Temperature.*—This is necessarily dependent on the heat of the materials passed through.

Springs of variable temperature superficial in their origin, and irregular in their quantity of water.

Springs of ordinary uniform temperature equal to the mean atmospheric heat. Usually nearly uniform in the quantity of water.

Hot Springs. Sources deeply seated. Probable cause of their high temperature.

The influence of *altitude* on the heat of springs.

3. *Contents.*—The percolating water must become impregnated with the soluble matter of the strata. Acidulated, chalybeate, saline, and sulphureous springs. The tests by which they may be distinguished. The economical importance of mineral waters.

3. Lakes.

To be viewed as detentions of water in opposition to gravity.

The *Basins* of lakes; referable to several different causes. The form of the margin. Terraces.—Parallel Roads.

The *Supply* of water, as derived from rain, streams, and springs, and the peculiar character of lakes as derived from these sources.

The *Removal* of the water,—by rivers, evaporation, and percolation.

The *Contents* of the water of lakes. Salt lakes and circumstances required for their production; the Caspian and the Dead Sea.

The *Temperature* of lakes. The reason why deep lakes do not freeze. The benefit to plants and animals from the *floating* of ice.

The processes going forward for the *Obliteration* of lakes. Their *silting up*, aided by the growth of plants and animals. The *wearing* down of the outlet. The *bursting* of the barrier, and the terraces left on the margin. Modes of determining the previous existence of lakes in a district.

The *Economical importance* of Lakes. Fish Ponds. Compensation Dams.

The Agitation of Lakes.

4. RIVERS.

Characterised by their fresh water; the current always in one direction, and the depth stationary, or varying irregularly.

The *Basin* of rivers; its connection with mountain ranges and valleys. The *Channel*; its mode of formation, sinuosities, reaches, rapids, cataracts, and occultations.

The *Quantity of Water* depending on the area of the basin, the elevation of the hills, and the annual fall of rain. The *periodical* changes in tropical and arctic rivers. *Floods;* the indication of their approach,—more frequent since the prevalence of draining.

The *Velocity;* the different influencing circumstances. The abrading power. The *quantity of mud* depends on the material and the velocity. The direction in which flat stones are placed in the channel. The *colour* of rivers.

The mode *of junction of rivers with rivers.* The direction of the new course and materials deposited. The *junction of rivers with lakes.* The distribution of transported materials.

The *Temperature* of rivers. The freezing, and the effects produced. *Ground Ice.*

The *uses* of rivers in the economy of nature. Their inflence on living beings, and on the distribution of disintegrated materials.

The *economical management* of rivers,—in reference to their waters and banks.

5. THE SEA.

Characterised by its salt water and its tides.

The *Basin* of the sea. Its peculiar configuration of margin and bottom. The *Saltness* of the sea. Origin of the salt. Circumstances by which the saltness may be modified. Has the saltness been variable?

The *Temperature of the Sea.* Influenced by latitude, but modified by *currents.* Temperature of tropical and arctic seas.

The *Tide waves.* Their origin and periodical changes. *Spring* and *Neap tides. High water*, and the influence of atmospheric pressure on the height attained. The *Establishment of a Port.* The *Velocity* of the tide wave, and the character of *Cotidal Lines.* The progress of the tide wave on the British coasts.

The *wind waves.* Their origin, magnitude, progressive motion, and momentum. The under littoral current. *Ripple* action on the materials of the beach. The *ripple mark.* Formation of *caves* in cliffs. *Ayres* or storm-raised beaches,—overlooked by many speculative geologists.

Currents.—The Gulf Stream, and the influence which it exercises by its temperature and transporting power.

The *Mean Level of the Sea.* The methods by which it may be determined. Influence of winds and currents. Relative level of different seas. The variable relation of land and water in reference to the mean level.

6. ESTUARY.

That space in a river which extends from its junction with the sea at low water, to the place where the tide ceases to influence its depth.

The *height* reached by a tidal wave and wind wave on entering a river. The influence of the *form* of the estuary. Mode of constructing *Harbours of Refuge.* The *Bore.*

The height of the *reverse current.* The difference in time of flood and ebb, the index of river influence.

The point of *Stagnation* depending on the mutual balancing of the sea and river. The influence of the sea beyond this point in reducing the velocity of the river.

The mode of *junction* of the fresh water of a river with the salt water of the sea,—as dependent on the relative densities of the two liquids, and on the state of the sea-beach. Formation of *Deltas.* Rivers with and without *Bars.* Rivers in connection with harbours. Scouring effects.

Proofs of the influence of sea water in rivers on vegetable and animal productions.

The *Limit of Sea and River. Fauces terræ. Ostium fluminis. Filum fluminis.* Although it be assumed in Acts of Parliament that there is a point where a river ends and the sea begins, yet the distinguishing character of that point has not been given, and litigation to a great amount has been the consequence. The *Physical* limit of sea and river. The Scottish *Statutory* limit. The origin of the misconceptions which have prevailed on the subject.

III.

THE CRUST OF THE EARTH.

The depth to which its structure has been explored. The relative proportion of land and water on the surface.

1. The *Temperature* of the crust, as determined by direct experiment and the heat of springs. *a.* The plane of temperature which varies with the *seasons* is of small thickness. The heat of summer penetrates to different depths, according to the materials. *b.* The plane of the mean temperature of the *climate.* The frozen soil of the arctic regions. *c.* The plane of *terrestrial* temperature,—reached at different depths, and apparently increasing downwards. Proofs of a *central heat.*

2. The *Structure* of the crust. The different materials and *states of aggregation.* The methodical distribution of the materials into Stratified, Unstratified, Igneous, Aqueous, Sedimentary, Crystalline, Metamorphic, and Venigenous. The mode of determining the *relative ages* of rocks by their mineral character, order of superposition, and their organic contents. The *fractures* and *dislocations* of the crust,—*slickensides.* The rocks may be conveniently divided into *Formations*, or coincident Geological, Phytological, and Zoological Epochs.

1.

MODERN EPOCH.

The materials belonging to this division of the crust of the earth are superficial, and form, where present, the *covering* or *tirring* of the older masses, the volcanic rocks being here for the present unnoticed. These superficial strata have been produced under different circumstances; serve to test not a few speculations; and, although neglected by many geologists, should occupy very closely the attention of those entering upon the study of this branch of Natural Science.

1. *Soil.—Inorganic Soil.* This is derived from the disintegration of rocks, and may be either primary or secondary. Circumstances favourable for destroying the aggregation of rocks. The escape of the *sap of rocks*, and consequent fissures. The decomposition by air and water. The *detritus* of the sides of hills assorted by water into angular or rounded gravel, sand, or mud.

The *agricultural character of soils* dependent on their texture and their relations to heat, moisture, air, and soluble contents.

2. *Vegetable Soil.*—Progress of vegetation on disintegrating rocks. The formation of Peat peculiar to cold climates. *a. Hill Peat.*—Plants favourable for its increase. *b. Lake Peat.*

—Peculiar mode of formation. *c. Forest Peat.*—Arises from the felling or overthrow of trees. The age of peat. The plants which prefer peat as a soil. The use of peat as fuel and for draining.

3. *Animal Soil.* The origin of Guano. Traces of it on different parts of the coast. The origin of the rich verdure around Hill Forts.

4. *Muirband* or Pan.—The circumstances which have contributed to its formation.

5. *Silt.* Materials of clay or sand in a state of minute division, and assorted by water. Has been formed in comparatively still water. Its organic contents. The origin of *Carses*, and their present elevation above the sea.

6. *Diluvium.* Sometimes denominated Boulder Clay, Drift, or Till; very imperfectly assorted by water. *Clay Diluvium;* very impervious to water. Its character as a soil. The contained stones usually rounded, and irregularly distributed. *Gravel Diluvium* of different ages. *Peat Diluvium.*

7. *Sand-drift.* Inland sand-drift. *Deserts.* Littoral sand-drift. Downs. Mode of stratification. Its ripple mark. Frequently covers vegetable soil.

8. *Raised Sea-Beaches.* Supposed of frequent occurrence. Much caution required in their examination. *Crag.*

9. *Submarine Forests.* Their contents, and the soil on which they rest. The causes of their submergence.

10. *Ice.* Polar Ice. The formation, motions, and effects of *Glaciers.* The character and effects of *Icebergs.* The *rubbed* surfaces of rocks. The origin of *Erratic blocks.*

11. *Spring Deposits.* Calcareous, Ferruginous, or Siliceous incrustations and depositions.

12. A review of the condition of vegetable and animal life during the formation of the superficial strata. The *extirpated* and *extinct animals.* Different positions of the contained organisms. *Bone-Caves. Licks.* The supposed agency of the *Noachian Deluge* in the formation of the superficial strata, and the distribution of their contained organisms. Many have indulged in *speculations* on this subject who have neglected to make themselves acquainted with the *facts* of the case. The relation of *Man* to this epoch of the history of the earth.

II.

PENULT EPOCH.

The materials belonging to this epoch occupy a position inferior to the superficial strata, and superior to those of the Chalk. The value of the terms Eocene, Miocene, and Pliocene.

Peculiar characters of the London and Paris Basins. The different kinds of *rock.* The alternations of lacustrine and marine deposits.

Review of the condition of vegetable and animal life during this epoch. The organisms not belonging to existing species. Their destruction from off the earth previous to the commencement of the modern epoch. The existence of carnivorous and insectivorous quadrupeds. Proofs of *physical death* on the earth before the creation of Man. The mode of viewing these statements as consistent with Scripture.

III.

CRETACEOUS EPOCH.

This includes the Chalk and Lias, and the intermediate deposits.

The structure of the beds of *Chalk.* Its original state and subsequent changes. The origin of *chalk flints.*

The composition and subdivision of the *green sand* series.

The *Wealden Beds.* Their contents. Are a fresh water formation.

The upper, middle, and lower *Oolites.* The *Dirt Bed.* *Fuller's Earth.*

The *Lias.* Its subdivisions. Character of its *Limestones.*

Review of the condition of vegetable and animal life during the cretaceous epoch. The existence of vegetable and animal soil. The *warm-blooded* animals of this period. Remarkable development of Reptiles. Ichthyosaurus, Pterodactylus, Iguanodon. *Belemnites* and *Ammonites* characterise this group.

IV.

SALIFEROUS EPOCH.

This group is frequently known from the red colour of some of its beds, as the *New Red Sandstone.* Remarkable for the prevalence of Chloride of Sodium, Sulphate of Lime, and Carbonate of Magnesia. The *Bone-bed.* Traces of *Rain-drops.*

The *Variegated* or *Upper* New Red Sandstone. The saliferous marls, limestones, and sandstones. The *Triassic* group.

The *Magnesian Limestone*, *Lower* New Red Sandstone, or *Permian* group. The composition and structure of the Limestone. The materials of the conglomerates.

Review of the condition of vegetable and animal life during the Saliferous Epoch. Batrachian Reptiles. Footsteps. Character of the Fishes as contrasted with those of the Cretaceous Epoch.

V.

CARBONIFEROUS EPOCH.

The contents of this group extend from the strata of the Saliferous Epoch to the oldest *fossiliferous* deposit, and may be conveniently subdivided into three formations :—

1. *Coal-Measures.* The origin of Coal, and the strata with which it is connected. The alternations of lacustrine and marine deposits. The peculiar character of the Sandstones, Ironstones, Shales, and Limestones of this period. The *Mountain* or *Encrinite Limestone.*

2. *Old Red Sandstone.* Sometimes termed the Devonian System. Its remarable *Conglomerates* and slaty sandstones. *Concretionary Limestone.*

3. *Transition Rocks.* Characterised by greywacke and slates. The subdivisions of the *Silurian Rocks.*

Review of the condition of vegetable and animal life during the Carboniferous Epoch. The characteristic fossils of these three formations. *The oldest organisms.* The amount of their resemblance to those of existing species, and do they furnish any indications of great differences in the condition of the air and waters when contrasted with existing arrangements? Erroneous views prevalent on this subject.

VI.

PRIMARY EPOCH.

The classification of the rocks, and their relative position. The extent of their sedimentary, fragmentary, and crystalline character.

Metamorphic, Plutonic, and Hypogene rocks. The importance of the *non-fossiliferous* characters of the primary rocks. The quantity of diffused carbonaceous matter.

IGNEOUS ROCKS.

The situation of *Volcanoes*, and their mode of action. *Craters.* The *Gases* emitted. *Lava. Ashes.* The presence of igneous rocks in the different formations, the extent to which they have been confounded with aqueous products, and the undue share of influence ascribed to them in the consolidation of the strata. Resemblance of Volcanic and Trap Rocks. The Trap Dykes and Beds in the neighbourhood of Edinburgh.

METALLIC VEINS.

The relative *ages of the metals*, as indicated by their connection with the strata of the different epochs. The directions and intersections of veins. The contents of veins. Review of opinions respecting the formation of veins.

The amount of truths subservient to the illustration of Natural Theology furnished by Geology. It demonstrates the operation of *Creative Power*, and the ripening of a plan whereby the earth was fitted for the habitation of Man.

CONCLUSION.

The complexedness of the scheme of inorganic and organised beings. The innumerable compensations, and the prevailing harmonies, furnish satisfactory evidence of *unity of design*, and the rule of SUPREME INTELLIGENCE.